# Autonomous Infrared Localization & Inspection System (AIRLIS)

## Team Falcon-Map / United States Air Force Academy

C1C/David Ke, C1C/Elliott Kmetz, C1C/Joseph Olson, C1C/Ashlynn Sweet
Dr. Humberto Ramos / Research and Engineering Education Facility

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## INTRODUCTION / MISSION

**Objective:** Increase the robustness, frequency, and efficiency of aircraft battle damage inspections with non-destructive methods.

**Solution:** This research uses an unmanned aircraft system (UAS) with off-the-shelf infrared (IR)-based sensors to autonomously identify and localize battle damage on aircraft. The system operates using a single computer containing a convolutional neural network (CNN) and a Simultaneous Localization and Mapping (SLAM) algorithm to detect, classify, and localize each instance of aircraft damage.

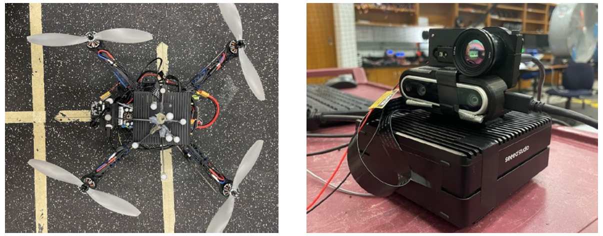

*Figure 1 and 2: Autonomous quadcopter and test hardware stack.*

## METHODS

The team developed and executed the plan below to support AFRL's operational mission.

1. Technical Research Deep Dive
2. Concept development of IR ML model
3. Integration of the ML model, SLAM algorithm, and navigation into one autonomous system
4. Experimental data collection on a test wing with the Aircraft Battle Damage Repair Site Lead at Hill AFB, UT

## TASKS / ACCOMPLISHMENTS

- Accomplished a demonstration of an autonomous quadcopter running a CNN to identify battle damage on a simulated aircraft wing while operating SLAM.
- Executed image calibration, rectification, and registration for an IR camera.
- Successfully harnessed Robot Operating System (ROS) for system integration and built skills applicable to current capstones.
- Developed competency using SLAM algorithms to enable autonomy.
- Created an IR dataset of damaged legacy aircraft on the Eglin Weapons Range and Hill AFB ABDR Site.
- Trained a CNN with IR images and tested it with real videos and on a mock plane wing.
- Reached out to multiple officers and NCOs for military expertise on impacts in theater.
- Awarded Best Track #9 Paper at the 2025 IEEE Aerospace Conference.

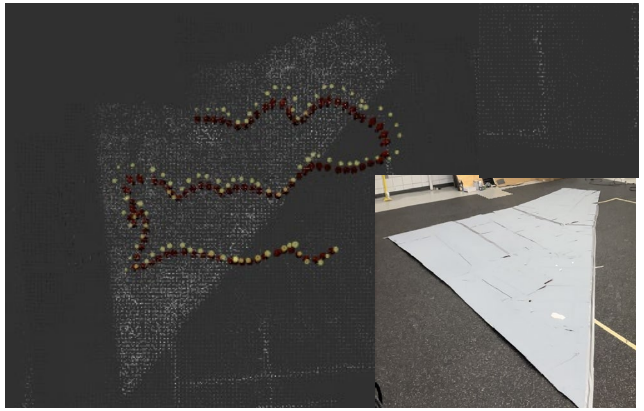

*Figure 3 and 4: Quadrotor live odometry during an autonomous test flight over a mock F-15 wing.*

## FUTURE PLANS

- Train another ML model with a larger high-fidelity dataset.
- Apply this ML model to new applications like space systems and evaluate the effectiveness of transfer learning in this realm.

## CONCLUSION

This research enabled us to learn and apply technical concepts to reliably demonstrate a novel battle damage identification system using an autonomous IR framework. Additionally, we engaged with multiple operational units and a diverse group of civilian researchers while building effective communication skills, civil-military relationships, and applicable robotics engineering knowledge.

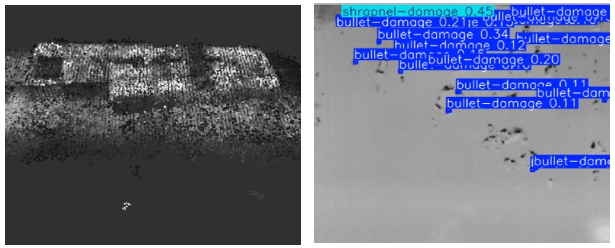


*Figure 5 and 6: Overall map of battle damage on the T-37 wing and ML model identified damage.*

## ACKNOWLEDGEMENTS:

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